

Structural Evolution of a Warm Frontal Precipitation Band During GCPEX

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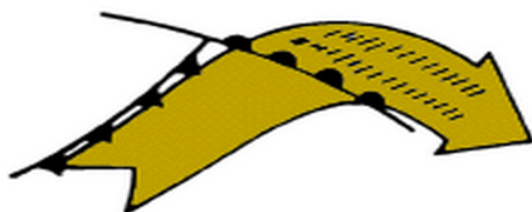


**Stony Brook
University**



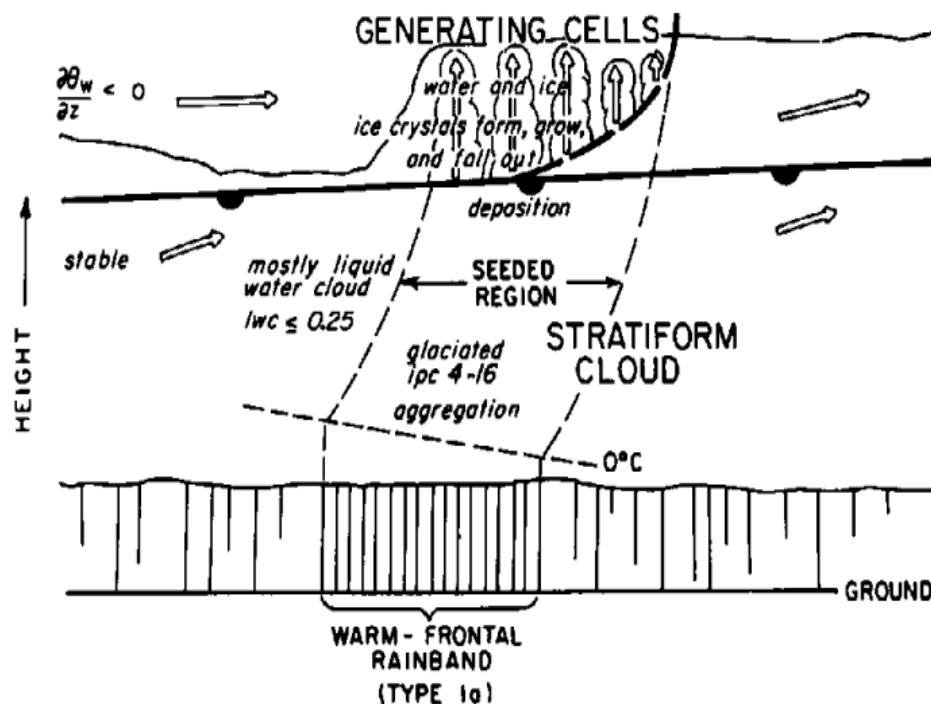
**Support: NSF AGS-1347499 and
NASA NNX13AF88G**

WARM FRONTAL BANDS



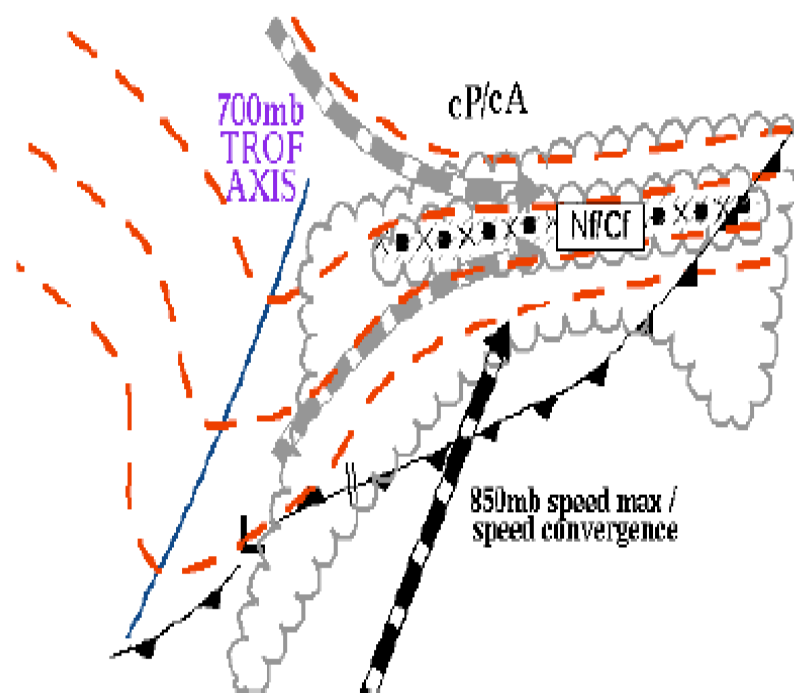
Browning
(1986)

Instability/generating
cells aloft



Previous Warm Frontal Band Studies

Low-level deformation/
frontogenesis



(b)

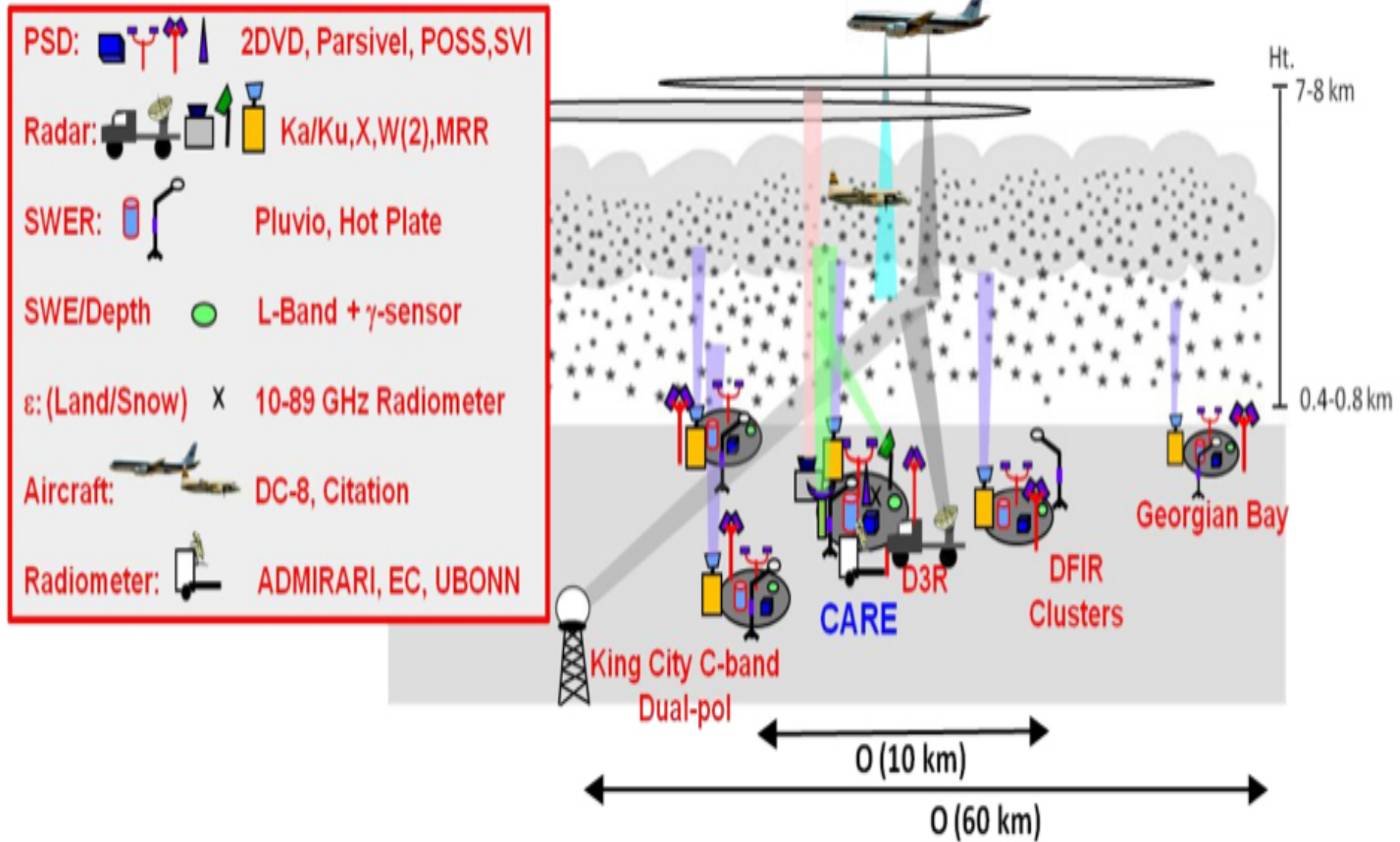
Hobbs 1978 and Matejka et al. (1980)

Banacos (2003)

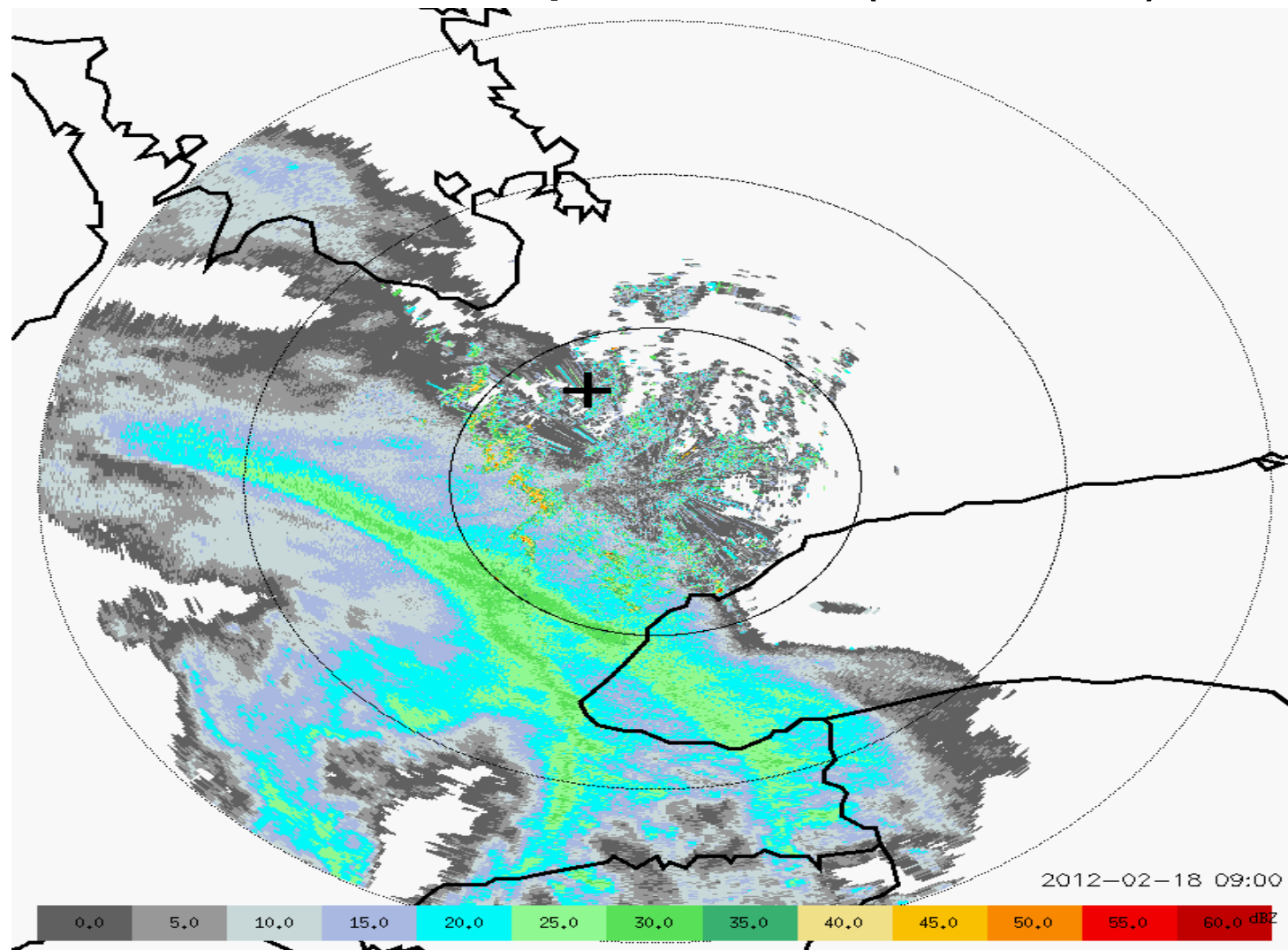
Global Precipitation Mission (GPM) Cold-season Precipitation Experiment (GCPEX 1/15/2012 - 2/29/2012)



GCPEx Instrumentation



Warm Frontal Precipitation Band (18 Feb 2012)



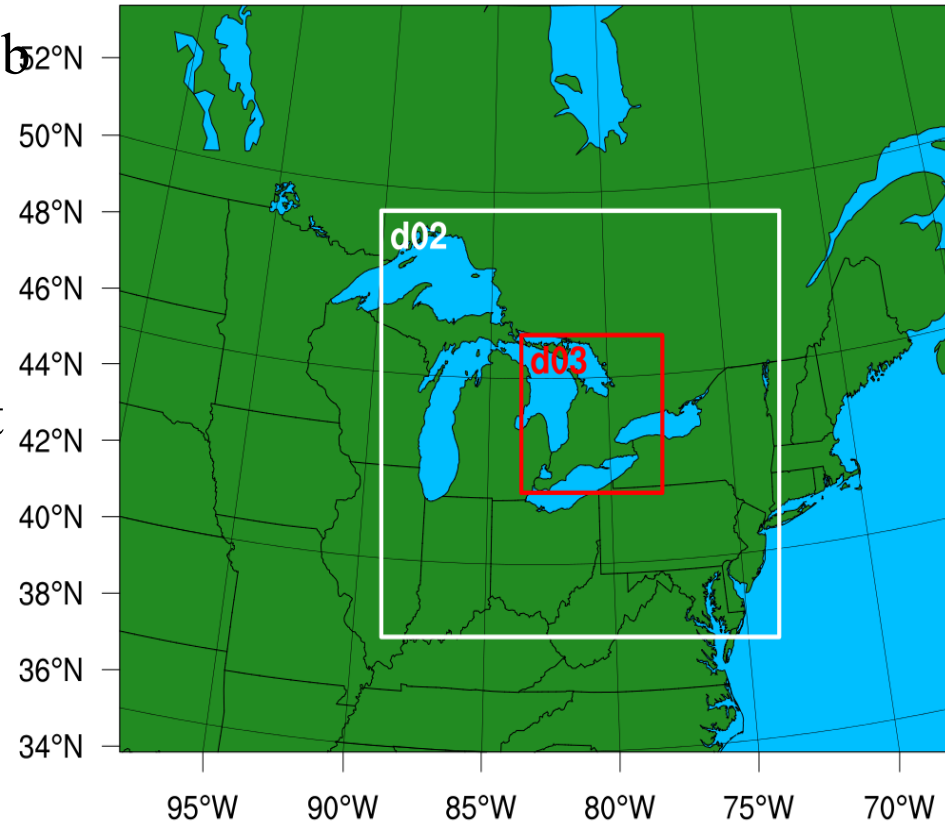
Motivation:

- There has been limited analysis of warm frontal precipitation bands.
- What processes led to the rapid spinup and evolution of the intense band? (See A.Naeger talk 10.6 for microphysical details)

Weather Research and Forecasting Simulations

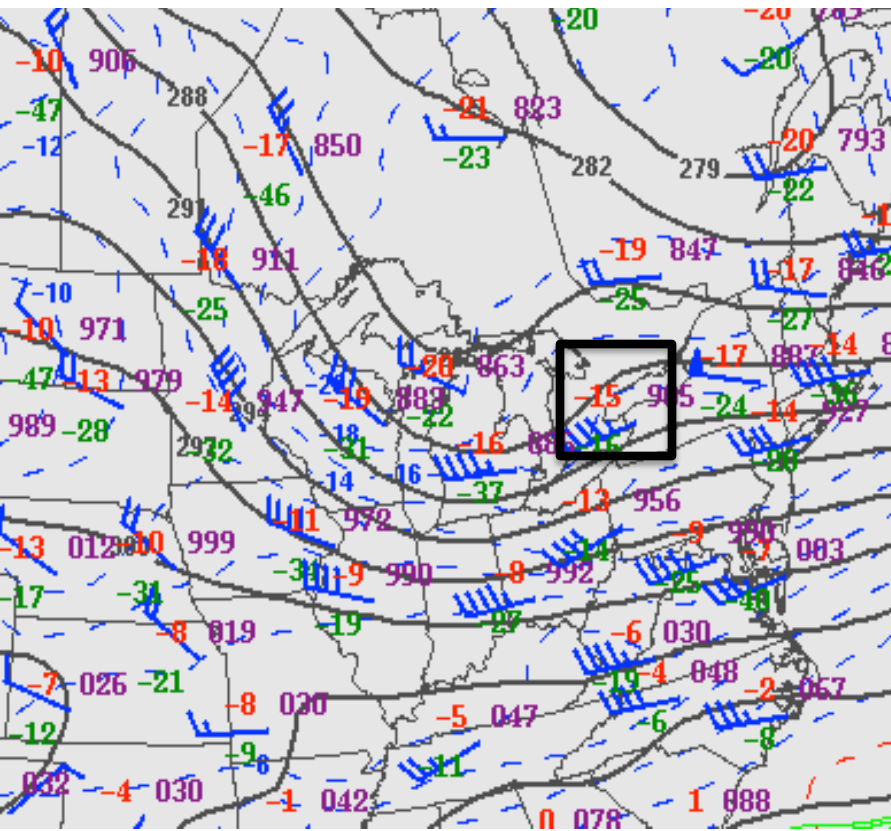
NASA-Unified-WRF configuration

IC and Boundary Conditions	6-h RUC Analyses starting 1800 UTC 17 Feb (30-h run)		
Vertical Resolution	50 Levels		
PBL Physics	Mellor-Yamada-Janjic		
Cloud microphysics	P3 scheme (Morrison et al. (2015))		
Short- and Longwave Radiation	RRTMG		
Horizontal Resolution	9 km	3 km	1 km
Cumulus scheme	Grell-Freitas	Turned off	Turned off

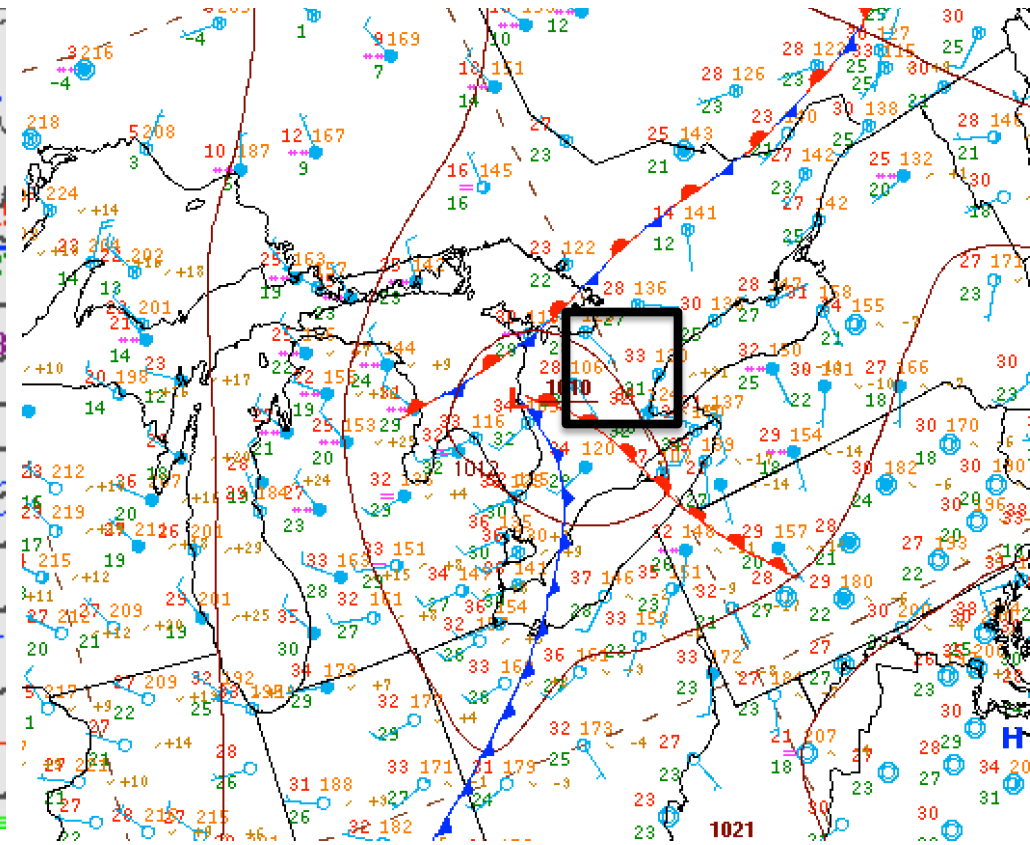


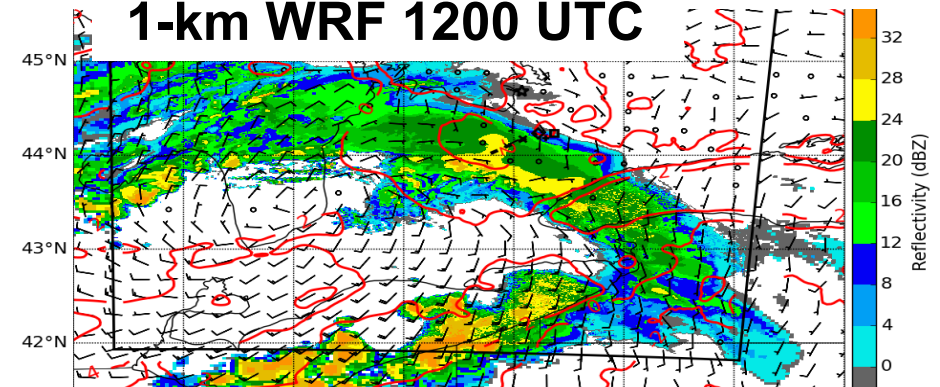
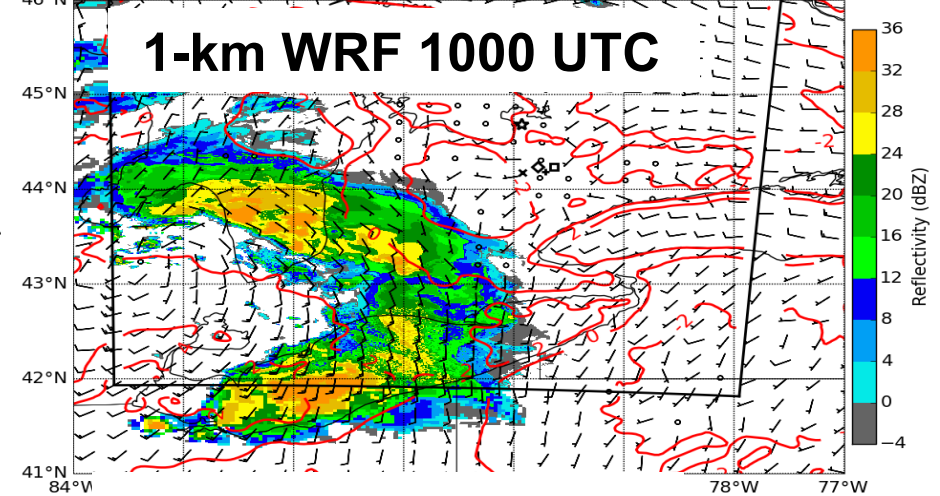
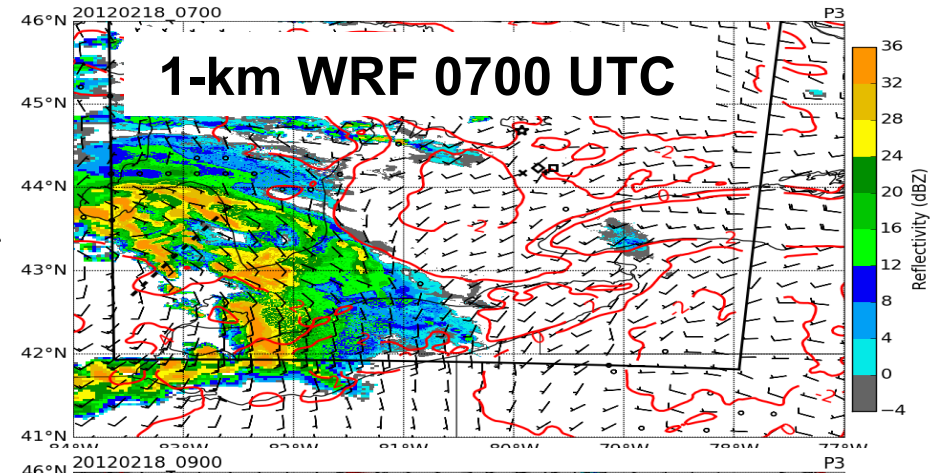
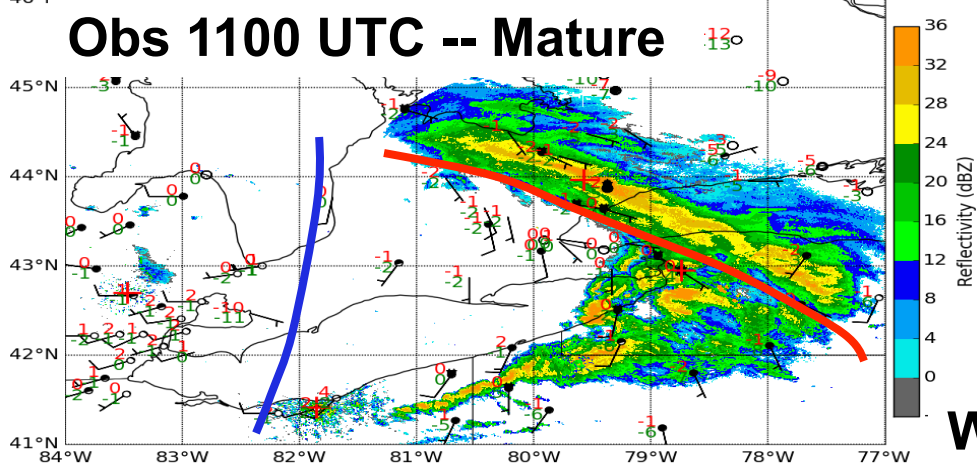
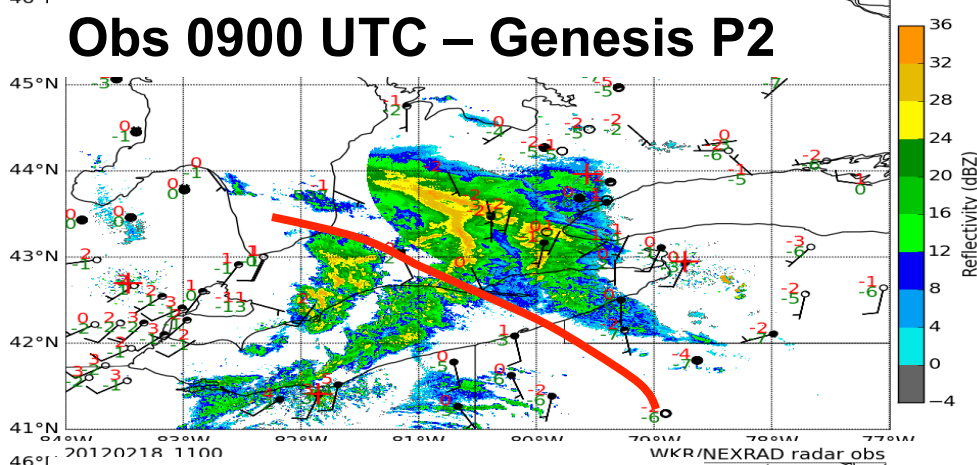
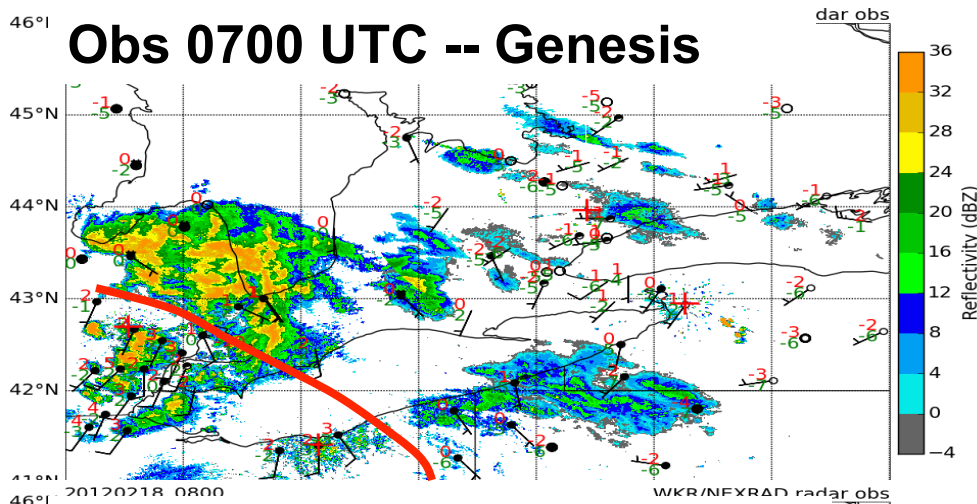
1200 UTC 18 February 2012

700 hPa Analysis

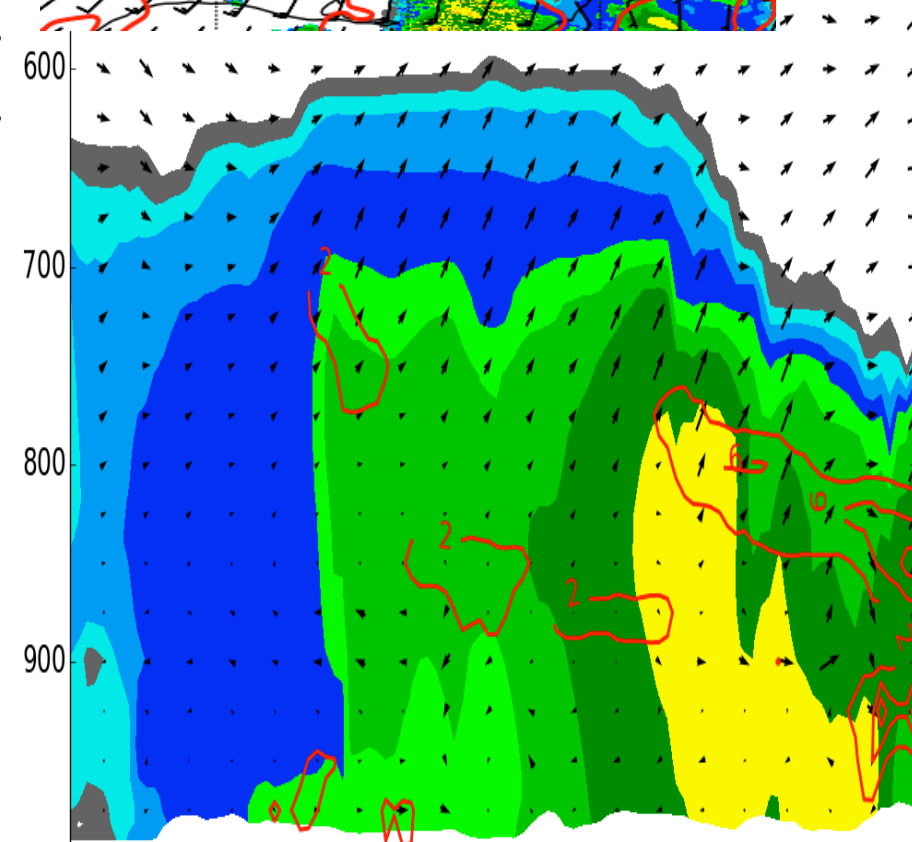
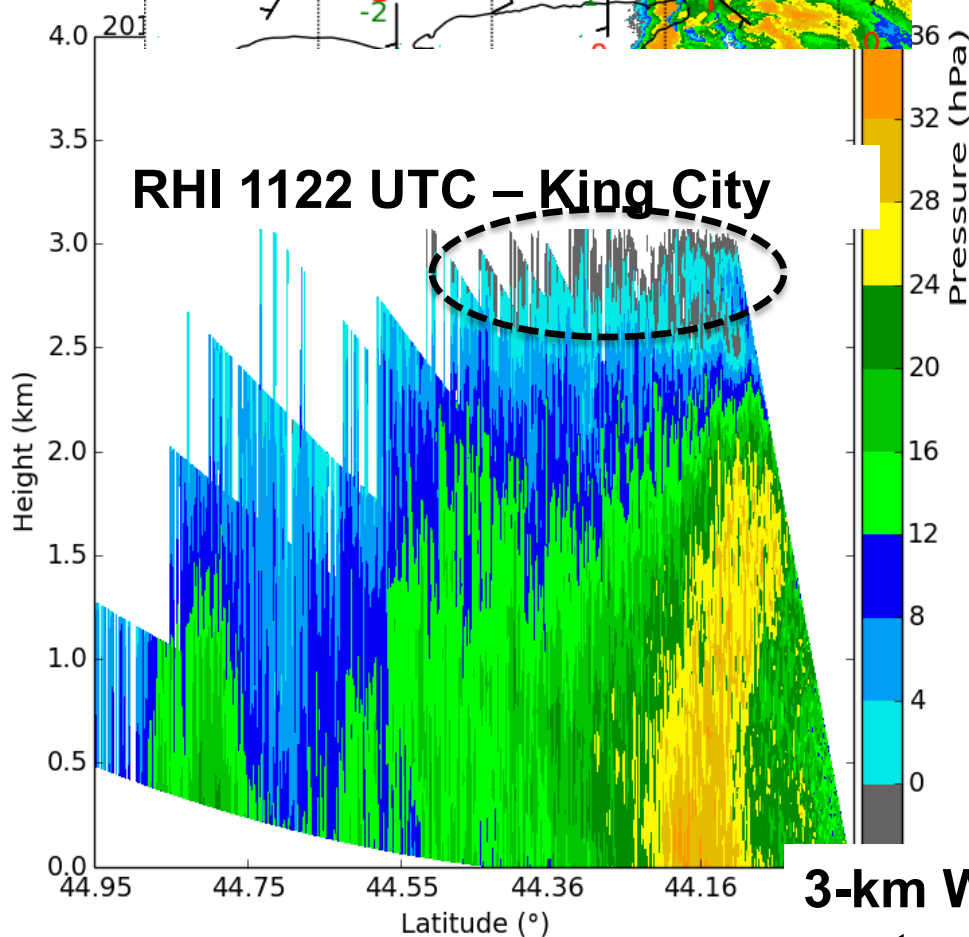
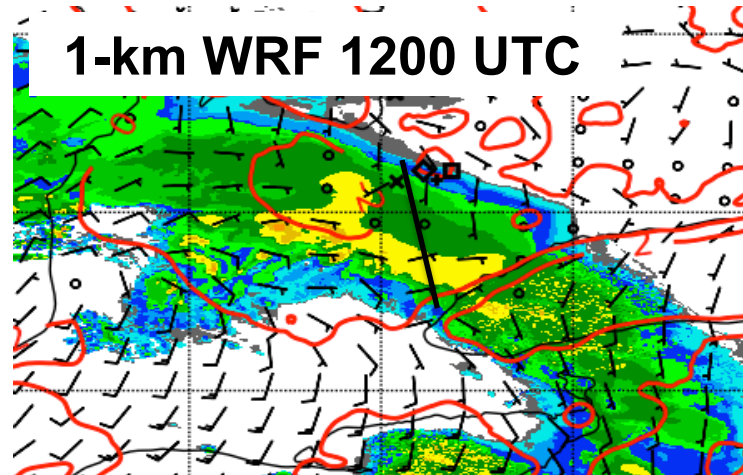
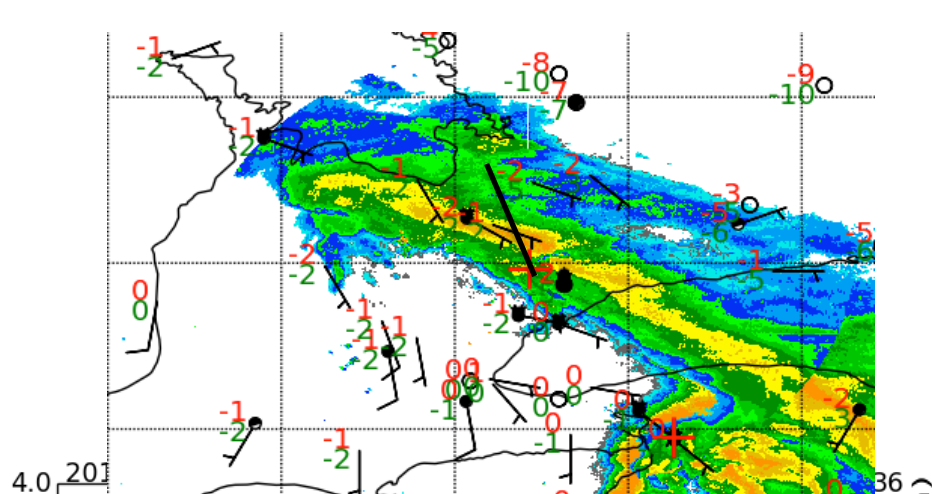


WPC Surface Analysis





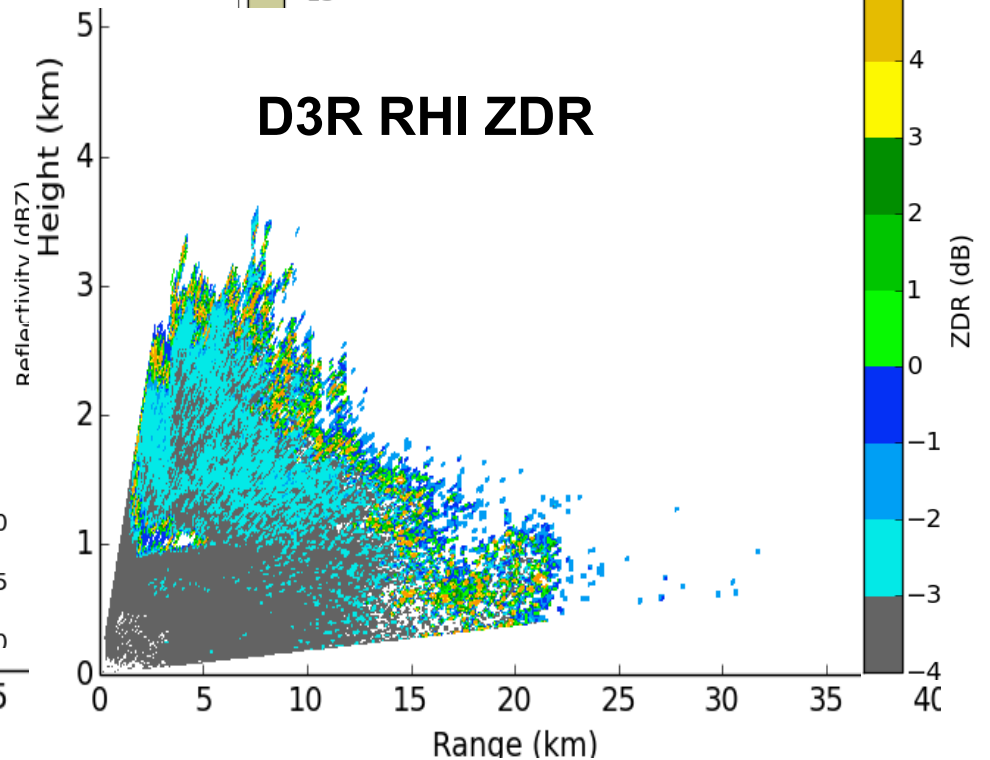
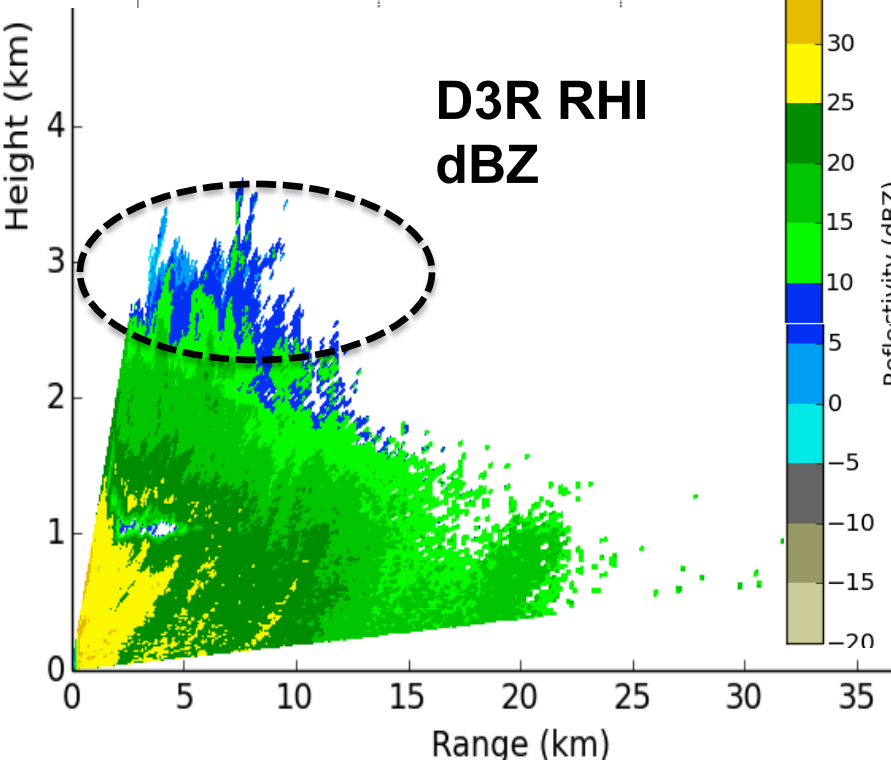
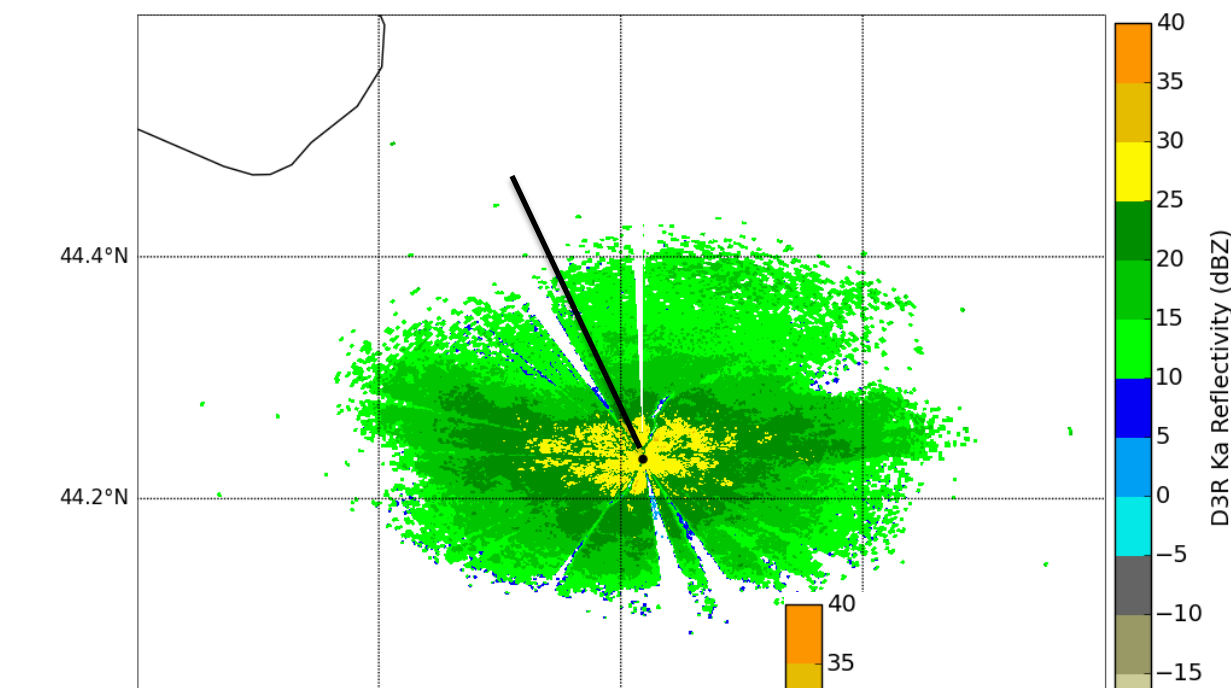
WRF: surface winds; 2-m Temp (red)

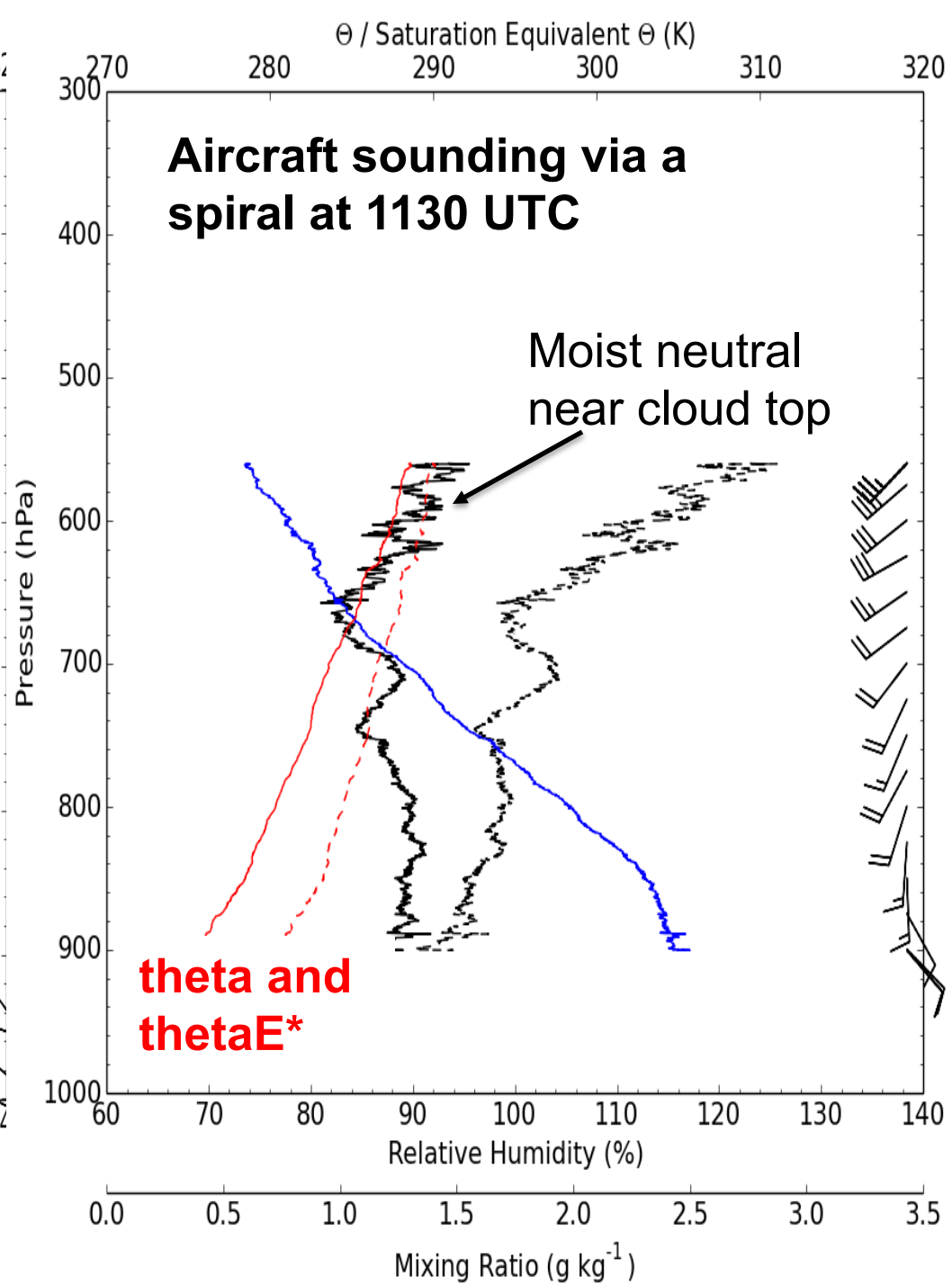
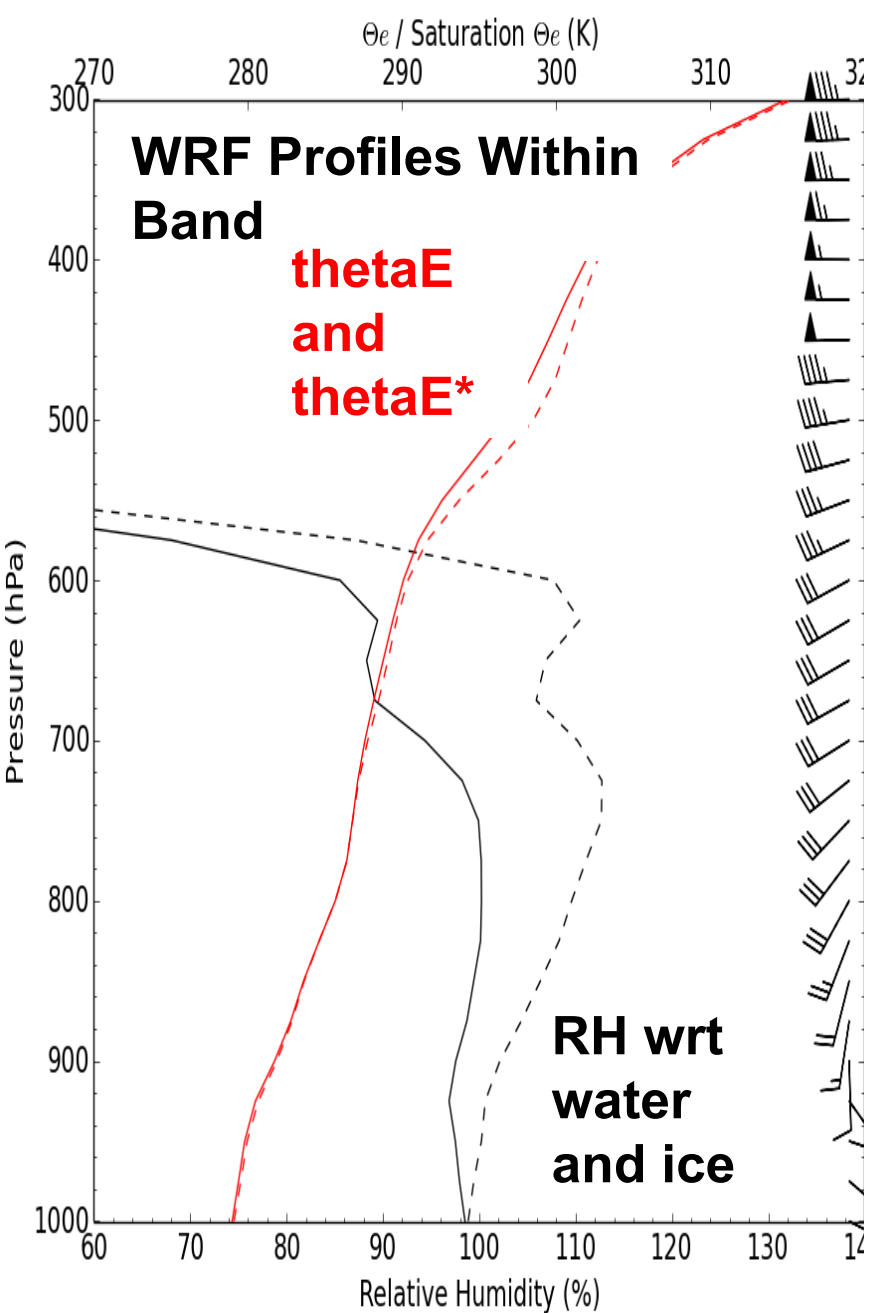


3-km WRF cross section: dBZ, circulation vectors, and Miller 2-D frontogenesis – red)

Precipitation band over D3R Dual Pol radar at 1200 UTC 18 Feb

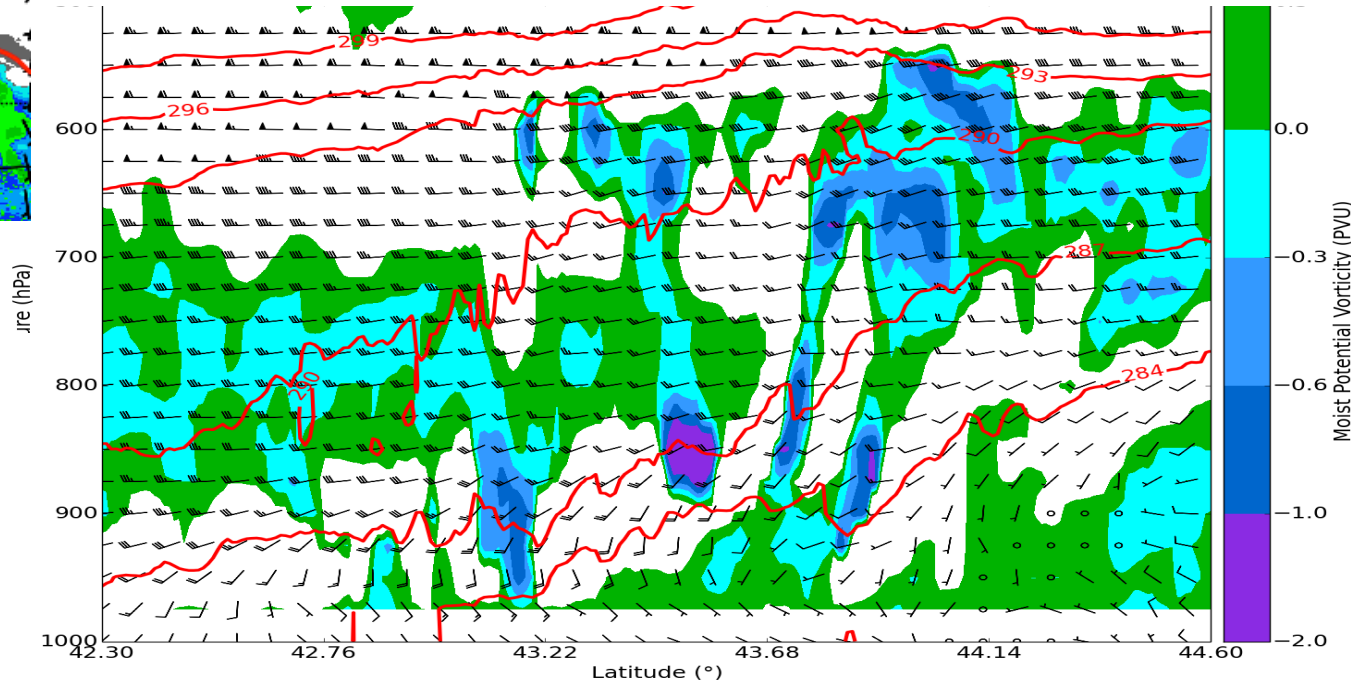
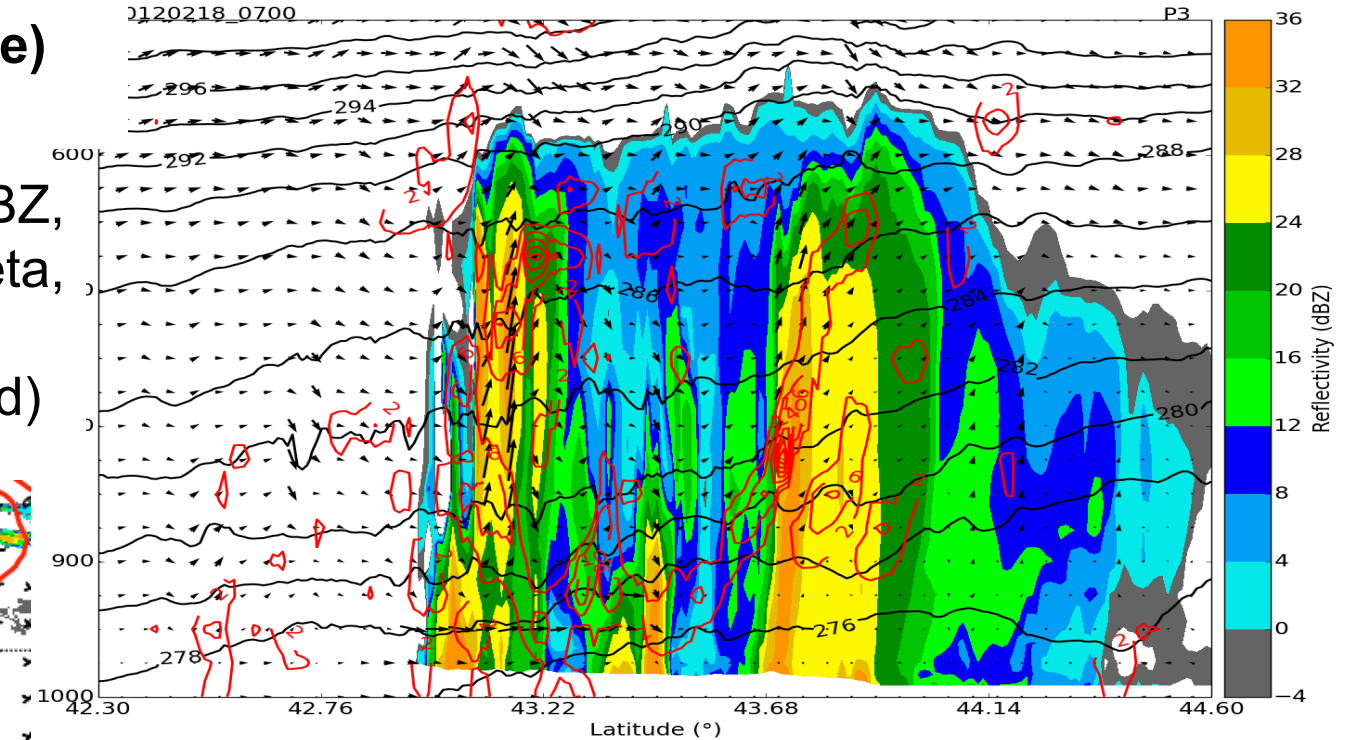
Cloud top
generating cells –
similar to
Plummer et al.
(2015)





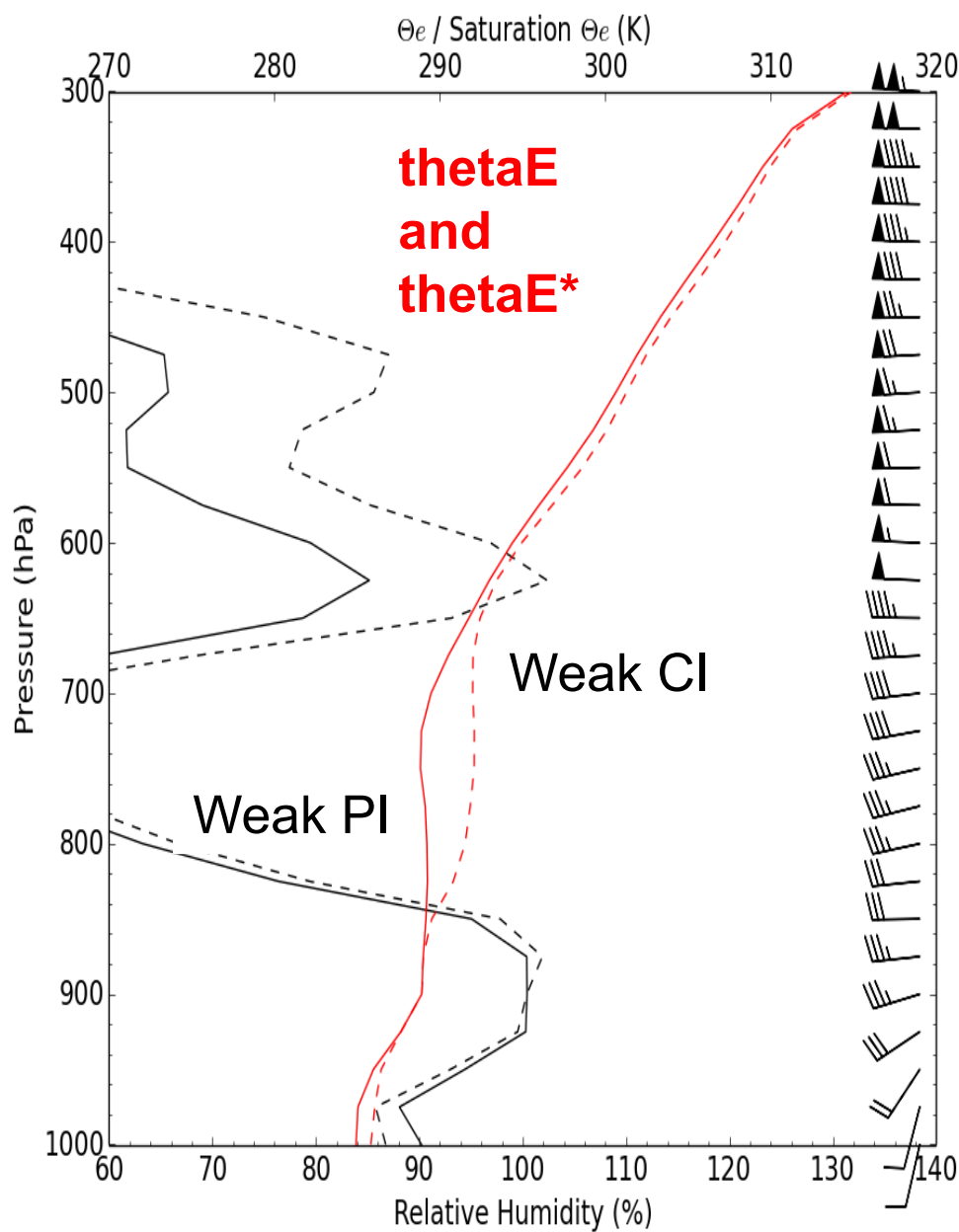
WRF (Genesis Stage) 0700 UTC 18 Feb

WRF cross section: dBZ,
circulation vectors, theta,
and Miller 2-D
frontogenesis, top - red)

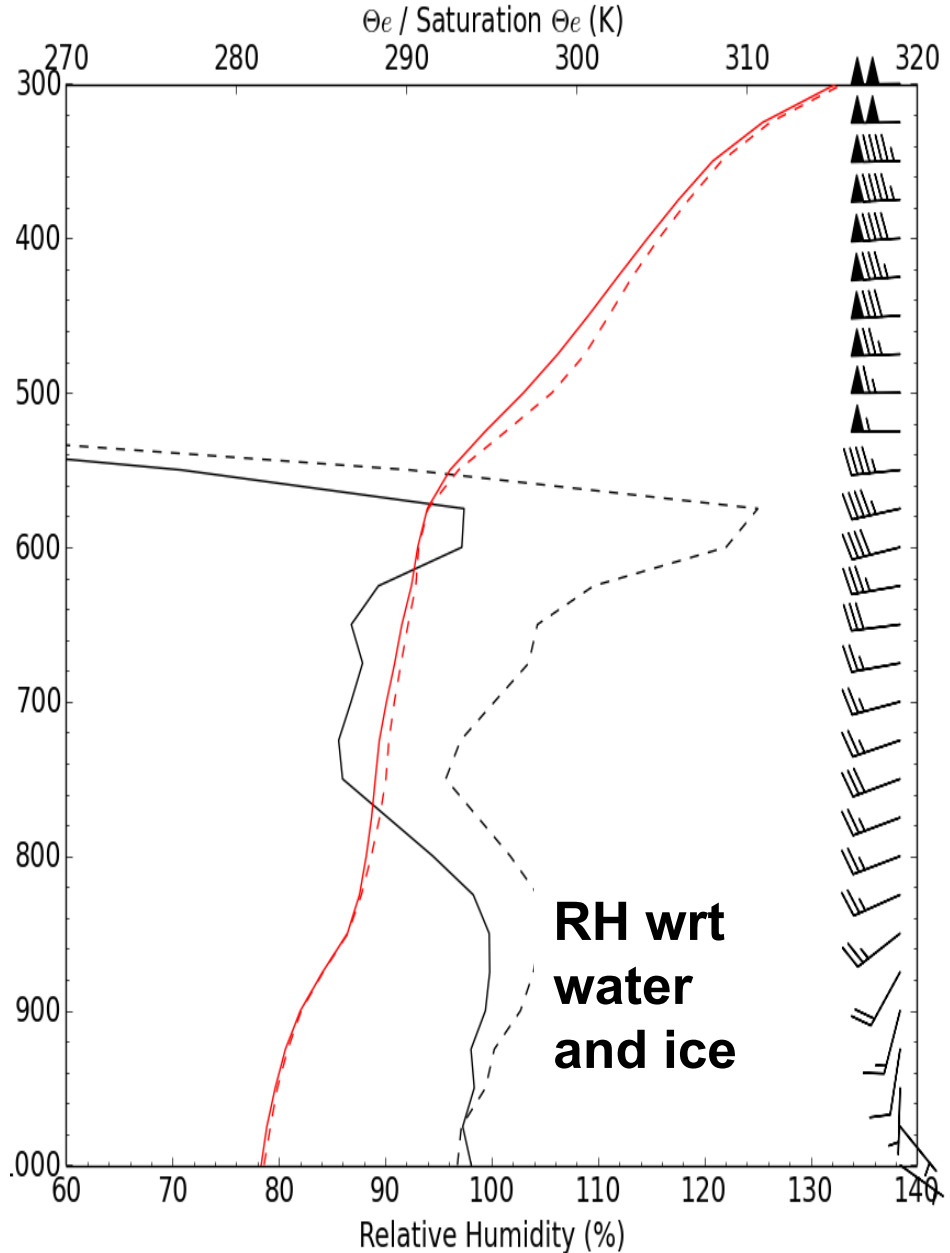


WRF cross section:
MPV* shaded, horiz
winds, and thetaE*

WRF Profile Just South of Band

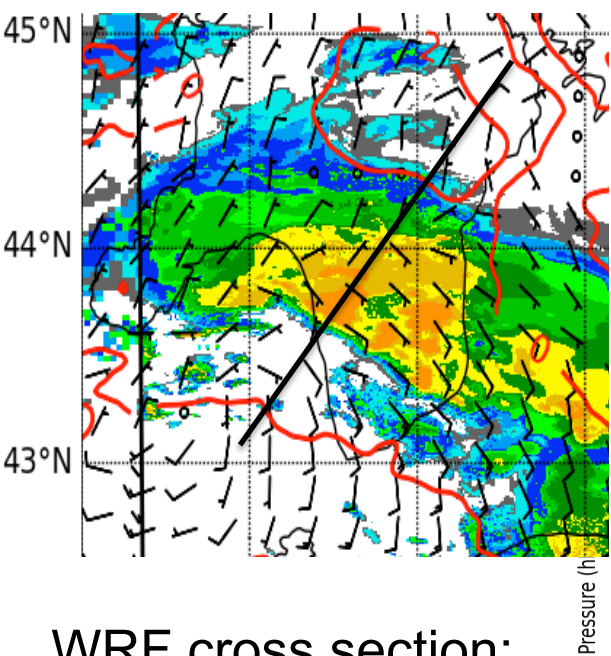


WRF Profile Within Band

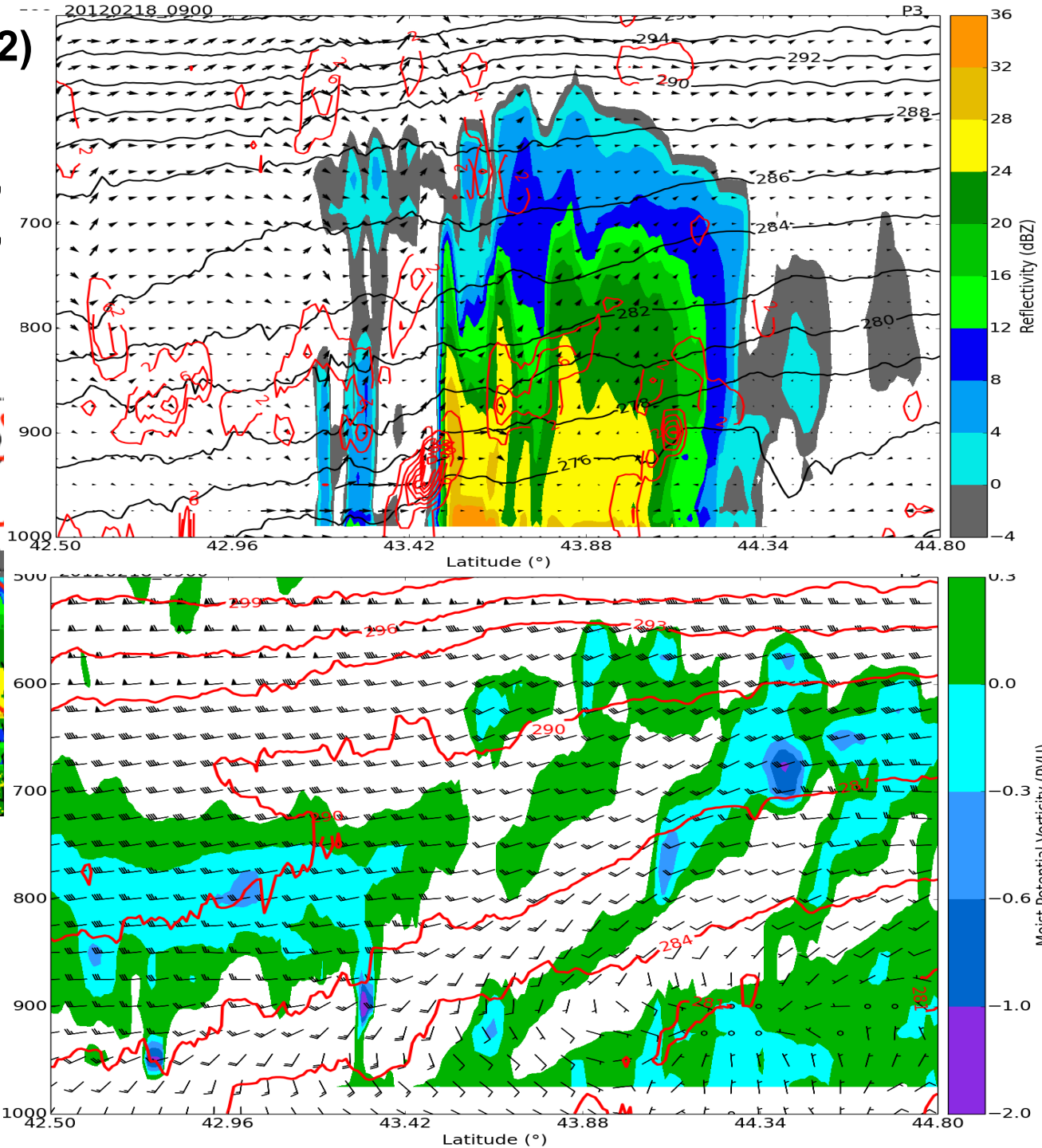


WRF (Genesis Stage P2)
0900 UTC 18 Feb

WRF cross section: dBZ,
circulation vectors, theta,
and Miller 2-D
frontogenesis, top - red)



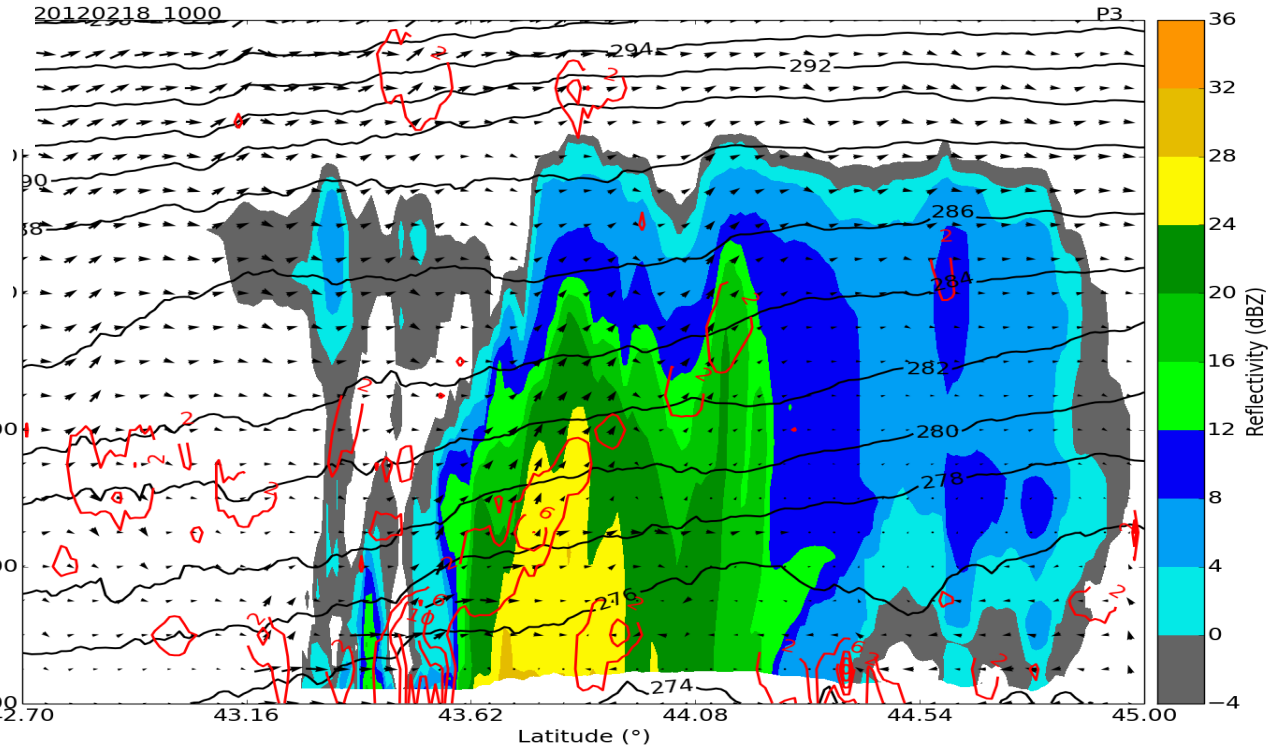
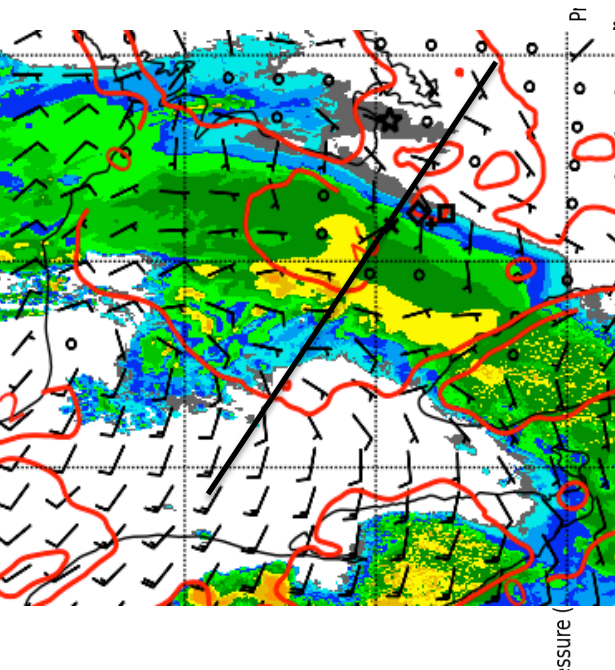
WRF cross section:
MPV* shaded, horiz
winds, and thetaE*



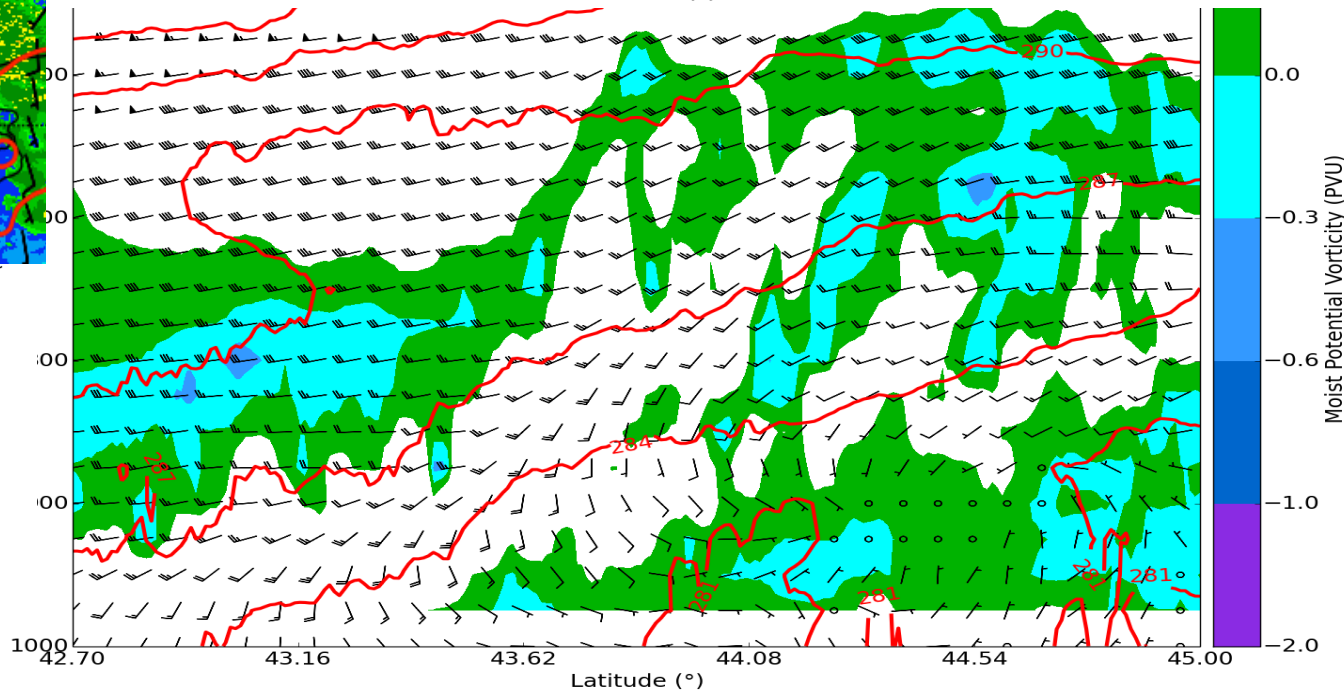
WRF (Mature Stage)

1200 UTC 18 Feb

WRF cross section: dBZ,
circulation vectors, theta,
and Miller 2-D
frontogenesis, top - red)

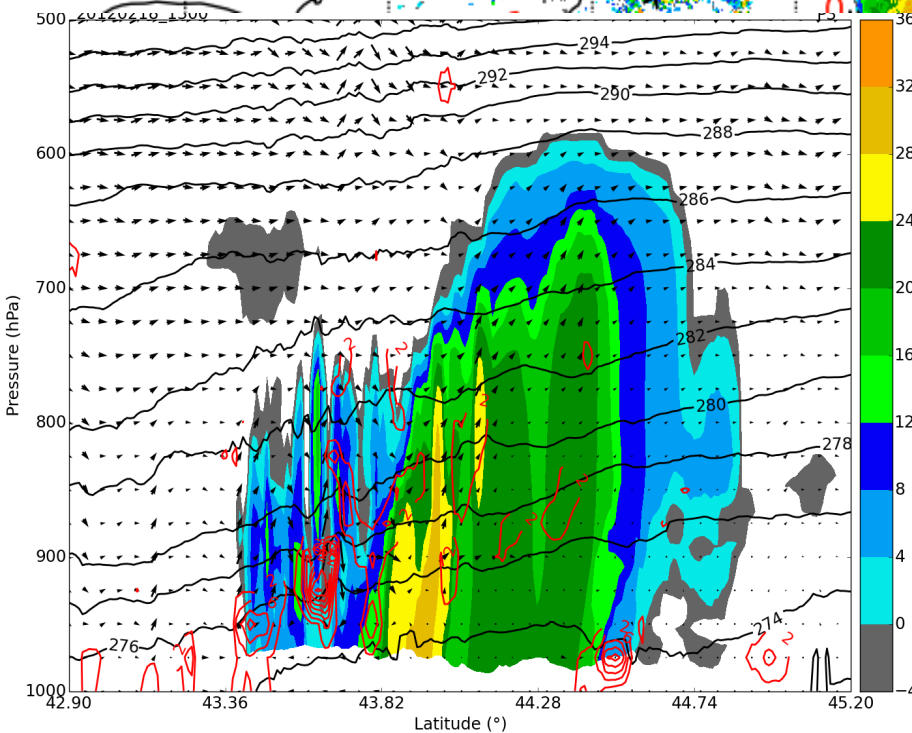
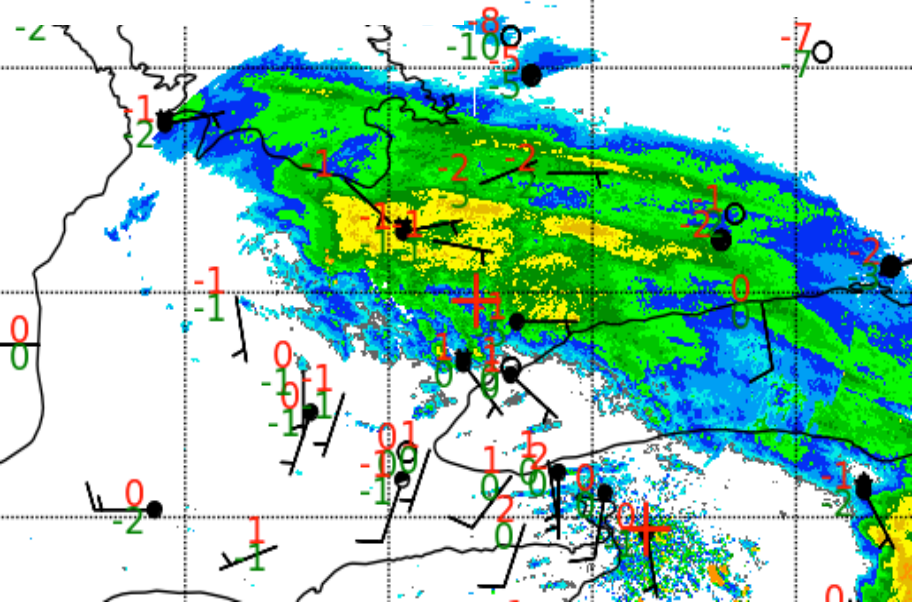


WRF cross section:
MPV* shaded, horiz
winds, and thetaE*

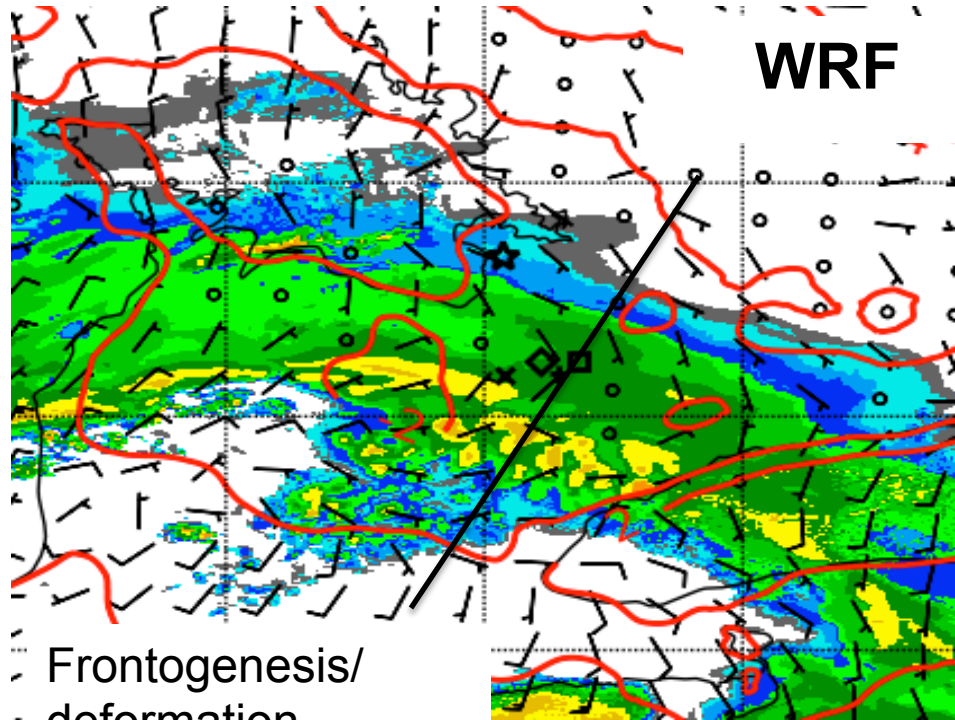


Decay Stage

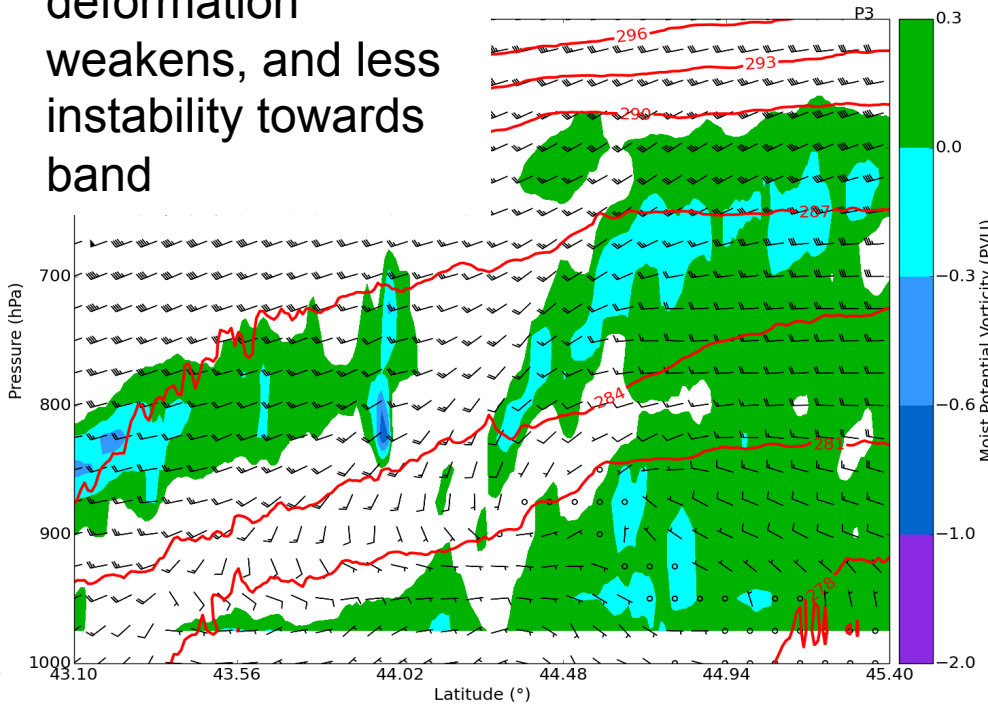
Obs



WRF



Frontogenesis/
deformation
weakens, and less
instability towards
band



Summary

- A warm frontal precipitation band developed over a few hours 50-100 km to the north of a surface warm front. The 3-km WRF was able to realistically simulate band development, although the model is somewhat too weak.
- Band genesis was associated with weak frontogenesis (deformation) in the presence of weak potential and conditional instability feeding into the band region, while it was closer to moist neutral within the band.
- As the band matured, frontogenesis increased, while the stability gradually increased in the banding region. Cloud top generating cells were prevalent, but not in WRF (too stable).
- The band decayed as the stability increased upstream and the frontogenesis (deformation) with the warm front weakened.
- The WRF may have been too weak and short-lived with the band because too stable and forcing too weak (some micro issues as well).